

Lesson Title: Pendulum Demonstration Activity

Subject area/ Course/grade level: Science/ Energy/ 6th Grade

Introduction: This lesson assumes students have already been exposed to gravitational potential energy and kinetic energy. A raised pendulum bob has gravitational potential energy. Release it and the gravitational energy is converted into kinetic energy and the bob approaches the lowest point. As the bob swings to the other side, kinetic energy is again converted into gravitational potential energy.

Lesson Length: 1 hour

Materials: Pendulums, Ring Stands, Pendulum clamps, meter sticks, string

Lesson Overview: Students will answer questions in relation to a pendulum demonstration.

Tennessee Standards:

GLE 0607.10.1 Compare and contrast the three forms of potential energy.

0607.10.1 Compare potential and kinetic energy.

GLE.0607.10.3 Explain the principles underlying the Law of Conservation of Energy

0607.10.4 Explain why a variety of energy transformations illustrate the Law of Conservation of Energy.

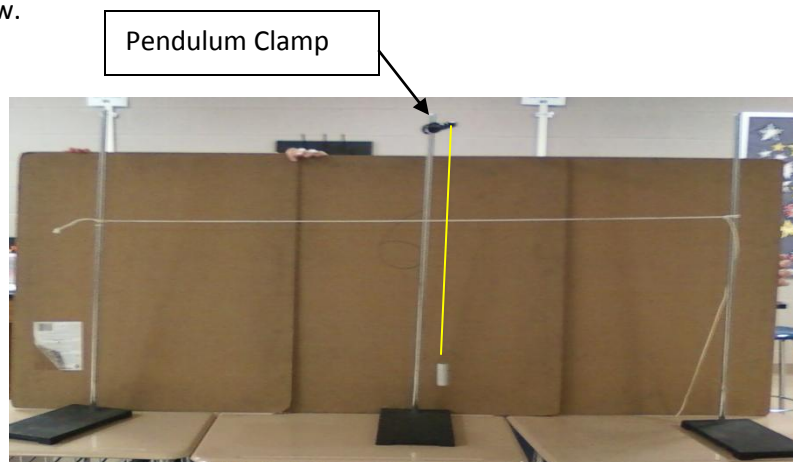
SPI 0607.10.2 Interpret the relationship between potential and kinetic energy.

SPI 0607.10.3 Recognize that energy can be transformed from one type to another.

SPI 0607.10.4 Explain the Law of Conservation of Energy using data from a variety of energy transformations.

Lesson Objectives: To investigate the principle of conservation of energy with a pendulum.

DEMONSTRATION SETUP. Set up a pendulum attached to a pendulum clamp (white arrow is pointing to clamp) with a string (yellow line in photo below) from a ring stand. Using two more ring stands, tie a string across the middle of the pendulum string to show the height the pendulum will be released from. See photo below.

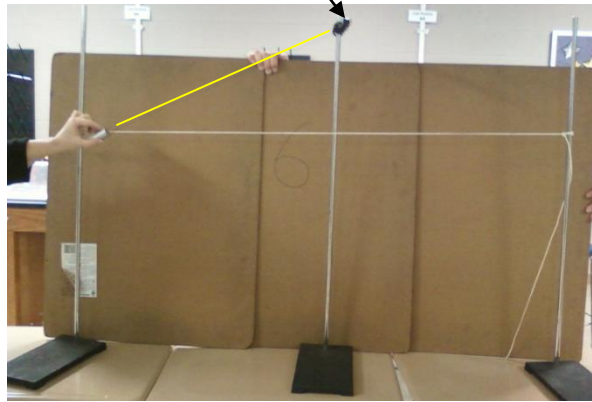


ENGAGEMENT

- Release the pendulum from the height marked by the string. See photo at below. While watching the pendulum swing back and forth, using their lab notebooks, students are asked to draw a diagram of a pendulum in motion. Students need to identify where the maximum gravitational energy and maximum kinetic energy positions are located. Draw a diagram to help them get started if necessary.

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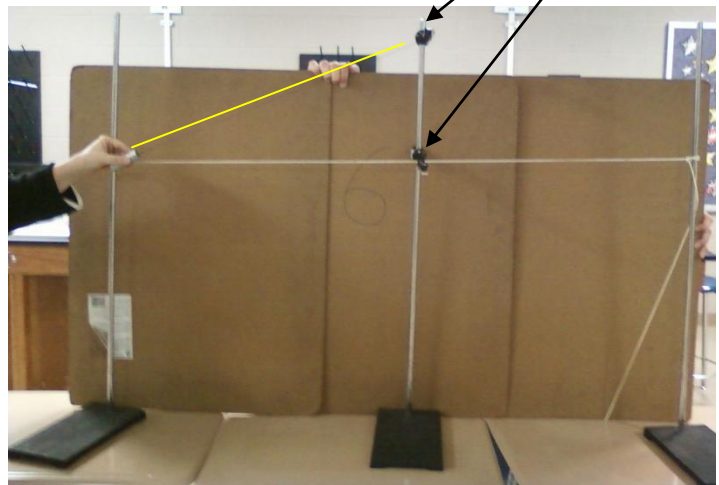
Pendulum Clamp



- Stop the pendulum and place a rod (or pendulum clamp) across the pendulum path at the height of the string. See photo below. Ask the students to predict what will happen to the pendulum when it hits the rod after being released from string level. Do not allow students to answer out loud, but to make their predictions in their lab notebooks. Use the three choices listed below.

Pendulum Clamp

- 1) The ball will go higher than the horizontal string.
- 2) The ball will go just as high as the horizontal string.
- 3) The ball will not go as high as the horizontal string.



- After each student has had sufficient time to record their predictions, allow them to collaborate and write their answers on white boards in groups of three or four.
- Allow each group to present their prediction to the class. Try not to make any signals as to whether the answers are correct or incorrect. Be sure to ask each group to explain why they have chosen their answer. If they are guessing, and do not have any scientific reasoning behind their answer, get them to admit it. Then try to get them to identify any scientific process that would explain their answer.
- After each group has finished their presentation, release the pendulum and have each student record their observations. (*The pendulum should return to the level it was released.*)

EXPLORATION

- Now that students have had some exposure to this situation, it is time to apply scientific reasoning to new situations.
- Move the rod to a position above the release position (about 4 inches) and ask the students what would happen if the pendulum were released from the original height. Have them predict in their lab notebooks what they think will happen.
 - 1) The ball will go higher than the horizontal string.
 - 2) The ball will go just as high as the horizontal string.
 - 3) The ball will not go as high as the horizontal string.
- Have students collaborate in groups of three or four and write their results on white boards. Each group should be allowed to present their results to the class.
- Release the pendulum and allow it to hit the rod located at a higher position. Allow students time to record their observations. (*The pendulum should return to the height it was released.*)
- Repeat this process for when the rod is placed lower than the release position. Only move the rod about 3 inches below. If you move it too low, there will not be enough string to reach the original height and the pendulum will loop over. (*The pendulum should return to the height it was released.*)

ANALYSIS

- After all groups have recorded their observation for all three situations, ask the students if there was a common result.
- Have students identify the maximum gravitational potential energy and kinetic positions for all three situations.
- After students realize that the final potential energy always equals the initial potential energy, define the Law of Conservation of Energy. Allow students to use their lab notebooks to record this definition.

- Point out that all three experiments, the pendulum bob was released from the same height. Since all of that gravitational was eventually converted into kinetic energy and back to gravitational potential energy, the pendulum bob had to return to the same height.

EVALUATION

Students need to write a conclusion to this activity. Questions that need to be answered in their lab books:

- 1) Describe the motion of the pendulum in terms of the conservation of energy. (*Explanations should state that the sum of the kinetic energy and gravitational potential energy is conserved.*)
- 2) How high can the rod be positioned before the pendulum bob is not able to return to the original height? (*The highest point is the height of the pendulum clamp.*)
- 3) How low can the rod be placed and the pendulum is still able to return to the original height? (*If the rod is lower than $2/5^{th}$ the distance between the lowest position of the ball and the height of the string, the ball does a loop-the-loop and does not return to the original height.*)

EXTENSION

- Have students design an experiment to investigate what makes the pendulum slow down and come to a stop.
- Have students design an experiment to investigate how the mass of the pendulum changes the motion of the pendulum. (NOTE: Be sure to keep the length of the pendulum the same when trying this experiment!).
- Have students design an experiment to investigate how the length of the string changes the motion of the pendulum.
- Have students design an experiment to investigate how the height of release changes the maximum kinetic energy at the bottom of the motion.
- If enough equipment is available, have students test to see if there is an upper limit or lower limit to where the rod is placed resulting in the pendulum bob not returning to its original height.

Reference

Adapted from: Conceptual Physics Laboratory Manual by Paul Robinson, Third Edition. Addison Wesley (1997) pp. 77-78.

Equipment Sources

1) Pasco Pendulum Clamp can be found at www.Pasco.com Item No. SE-9443 or

http://store.pasco.com/pascostore/showdetl.cfm?&DID=9&Product_ID=1570&groupID=455&Detail=1



2) Pasco Pendulum set can be found at: www.pasco.com Item no. ME-8752 or

http://store.pasco.com/pascostore/showdetl.cfm?&DID=9&Product_ID=1499&groupID=455&Detail=1



3) Pasco Pendulum String can be found at www.pasco.com Item No. Me-9875 or

http://store.pasco.com/pascostore/showdetl.cfm?&DID=9&Product_ID=54946&groupID=672&Detail=1